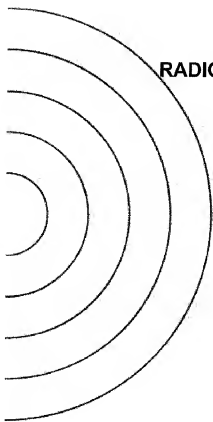
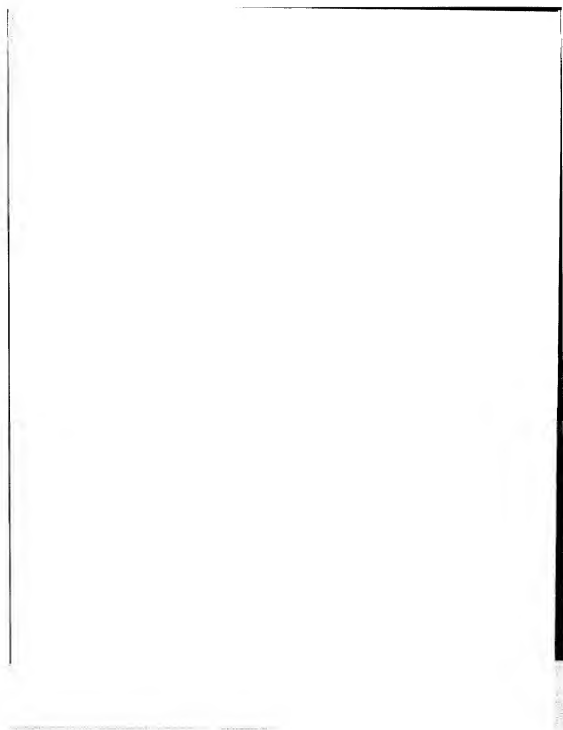


Part A

RADIO SPECIFICATION





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1 SCOPE

The Bluetooth transceiver is operating in the 2.4 GHz ISM band. This specification defines the requirements for a Bluetooth transceiver operating in this unlicensed band.

Requirements are defined for two reasons:

- Provide compatibility between the radios used in the system
- Define the quality of the system

The Bluetooth transceiver shall fulfil the stated requirements under the operating conditions specified in Appendix A and Appendix B. The Radio parameters must be measured according to the methods described in the RF Test Specification.

This specification is based on the established regulations for Europe, Japan and North America. The standard documents listed below are only for information, and are subject to change or revision at any time.

Europe (except France and Spain):

Approval Standards: European Telecommunications Standards Institute, ETSI

Documents: ETS 300-328, ETS 300-826

Approval Authority: National Type Approval Authorities

France:

Approval Standards: La Réglementation en France pour les Équipements fonctionnant dans la bande de fréquences 2.4 GHz "RLAN-Radio Local Area Network"

Documents: SP/DGPT/ATAS/23, ETS 300-328, ETS 300-826

Approval Authority: Direction Générale des Postes et Télécommunications

Note: A new R&TTE EU Directive will be in effect by March 2000, with consequent effects on the manufacturer's declaration of conformity and free circulation of products within the EU.

Spain:

Approval Standards: Suplemento Del Numero 164 Del Boletín Oficial Del Estado (Published 10 July 91, Revised 25 June 93)

Documents: ETS 300-328, ETS 300-826

Approval Authority: Cuadro Nacional De Atribución De Frecuencias

Japan:

Approval Standards: Association of Radio Industries and Businesses, ARIB

Documents: RCR STD-33A

Approval Authority: Ministry of Post and Telecommunications, MPT

Note: The Japanese rules are in revision. Decisions on the revision will take place in Q2 1999.

North Americas:

Approval Standards: Federal Communications Commission, FCC, USA

Documents: CFR47, Part 15, Sections 15.205, 15.209, 15.247

Approval Standards: Industry Canada, IC, Canada

Documents: OL36

Approval Authority: FCC (USA), Industry Canada (Canada)

1 GENERAL DESCRIPTION

Bluetooth is a short-range radio link intended to replace the cable(s) connecting portable and/or fixed electronic devices. Key features are robustness, low complexity, low power, and low cost.

Bluetooth operates in the unlicensed ISM band at 2.4 GHz. A frequency hop transceiver is applied to combat interference and fading. A shaped, binary FM modulation is applied to minimize transceiver complexity. The symbol rate is 1 Ms/s. A slotted channel is applied with a nominal slot length of 625 μ s. For full duplex transmission, a Time-Division Duplex (TDD) scheme is used. On the channel, information is exchanged through packets. Each packet is transmitted on a different hop frequency. A packet nominally covers a single slot, but can be extended to cover up to five slots.

The Bluetooth protocol uses a combination of circuit and packet switching. Slots can be reserved for synchronous packets. Bluetooth can support an asynchronous data channel, up to three simultaneous synchronous voice channels, or a channel which simultaneously supports asynchronous data and synchronous voice. Each voice channel supports a 64 kb/s synchronous (voice) channel in each direction. The asynchronous channel can support maximal 723.2 kb/s asymmetric (and still up to 57.6 kb/s in the return direction), or 433.9 kb/s symmetric.

The Bluetooth system consists of a radio unit (see Radio Specification), a link control unit, and a support unit for link management and host terminal interface functions, see Figure 1.1 on page 41. The current document describes the specifications of the Bluetooth link controller, which carries out the baseband protocols and other low-level link routines. Link layer messages for link set-up and control are defined in the Link Manager Protocol on page 183.

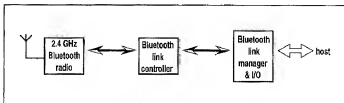


Figure 1.1: Different functional blocks in the Bluetooth system

The Bluetooth system provides a point-to-point connection (only two Bluetooth units involved), or a point-to-multipoint connection, see Figure 1.2 on page 42. In the point-to-multipoint connection, the channel is shared among several Bluetooth units. Two or more units sharing the same channel form a **piconet**. One Bluetooth unit acts as the master of the piconet, whereas the other unit(s)



acts as slave(s). Up to seven slaves can be active in the piconet. In addition, many more slaves can remain locked to the master in a so-called parked state. These parked slaves cannot be active on the channel, but remain synchronized to the master. Both for active and parked slaves, the channel access is controlled by the master.

Multiple piconets with overlapping coverage areas form a **scatternet**. Each piconet can only have a single master. However, slaves can participate in different piconets on a time-division multiplex basis. In addition, a master in one piconet can be a slave in another piconet. The piconets shall not be frequency-synchronized. Each piconet has its own hopping channel.

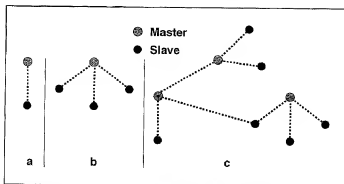


Figure 1.2: Piconets with a single slave operation (a), a multi-slave operation (b) and a scatternet operation (c)

Definitions

Baseband. The Bluetooth baseband specifies the medium access and physical layers procedures to support the exchange of real-time voice and data information streams and ad hoc networking between Bluetooth units.

Coverage area. The area where two Bluetooth units can exchange messages with acceptable quality and performance.

Host Terminal interface. Host terminal interface is the interface between Bluetooth Host and Bluetooth Unit.

Inquiry. A Bluetooth unit transmits inquiry messages in order to discover the other Bluetooth units that are active within the coverage area. The Bluetooth units that capture inquiry messages may send a response to the inquiring Bluetooth unit. The response contains information about the Bluetooth unit itself and its Bluetooth Host.

Isynchronous user channel. Channel used for time bounded information like i.e. compressed audio (ACL link).

Logical Channel. The different types of channels on a Physical Link.

Bluetooth Host. Bluetooth Host is a computing device, peripheral, cellular telephone, access point to PSTN network, etc. A Bluetooth Host attached to a Bluetooth unit may communicate with other Bluetooth Hosts attached to their Bluetooth units as well. The communication channel through the Bluetooth units provides almost wire-like transparency.

Bluetooth Unit. Bluetooth Unit is a voice/data circuit equipment for a short-range wireless communication link. It allows voice and data communications between Bluetooth Hosts.

Bluetooth. Bluetooth is a wireless communication link, operating in the unlicensed ISM band at 2,4 GHz using a frequency hopping transceiver. It allows real-time voice and data communications between Bluetooth Hosts. The link protocol is based on time slots.

Packet. Format of aggregated bits that can be transmitted in 1, 3, or 5 time slots.

Paging. An Bluetooth unit transmits paging messages in order to set up a communication link to another Bluetooth unit who is active within the coverage area.



Physical Channel. Synchronized RF hopping sequence in a piconet

Physical Link. Connection between devices.

Piconet. In the Bluetooth system, the channel is shared among several Bluetooth units. The units sharing a common channel constitute a piconet.

RFCOMM Client. An RFCOMM client is an application that requests a connection to another application (RFCOMM server).

RFCOMM initiator. The device initiating the RFCOMM session, i.e. setting up RFCOMM channel on L2CAP and starting RFCOMM multiplexing with the SABM command on DLCI 0 (zero).

RFCOMM Server. An RFCOMM server is an application that awaits a connection from an RFCOMM client on another device. What happens after such a connection is established is out of scope of this definition.

RFCOMM Server Channel. This is a subfield of the TS 07.10 DLCI number. This abstraction is used to allow both server and client applications to reside on both sides of an RFCOMM session.

Service Discovery. The ability to discover the capability of connecting devices or hosts

Scatternet. Two or more piconets co-located in the same area (with or without inter-piconet communication).

Time Slot. The Physical Channel is divided into 625 μ s long time slots.



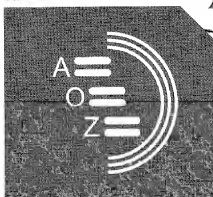
Specification Volume 0

Specification of the Bluetooth System

Wireless connections made easy

Master Table of Contents & Compliance Requirements

Covered Core Package version:
2.0 + EDR
Current Master TOC issued:
4 November 2004







Revision History

The Revision History is shown in the Appendix.

Contributors

The persons who contributed to this specification are listed in the Appendix.

Web Site

This specification can also be found on the Bluetooth web site:
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1 GENERAL DESCRIPTION

Bluetooth wireless technology is a short-range communications system intended to replace the cable(s) connecting portable and/or fixed electronic devices. The key features of Bluetooth wireless technology are robustness, low power, and low cost. Many features of the core specification are optional, allowing product differentiation.

The Bluetooth core system consists of an RF transceiver, baseband, and protocol stack. The system offers services that enable the connection of devices and the exchange of a variety of classes of data between these devices.

This chapter of the specification provides an overview of the Bluetooth system architecture, communication topologies and data transport features. The text in this chapter of the specification should be treated as informational and used as a background and for context-setting.

1.1 OVERVIEW OF OPERATION

The Bluetooth RF (physical layer) operates in the unlicensed ISM band at 2.4 GHz. The system employs a frequency hop transceiver to combat interference and fading and provides many FHSS carriers. RF operation uses a shaped, binary frequency modulation to minimize transceiver complexity. The symbol rate is 1 Megasymbol per second (Ms/s) supporting the bit rate of 1 Megabit per second (Mb/s) or, with Enhanced Data Rate, a gross air bit rate of 2 or 3 Mb/s. These modes are known as Basic Rate and Enhanced Data Rate respectively.

During typical operation a physical radio channel is shared by a group of devices that are synchronized to a common clock and frequency hopping pattern. One device provides the synchronization reference and is known as the master. All other devices are known as slaves. A group of devices synchronized in this fashion form a piconet. This is the fundamental form of communication in the Bluetooth wireless technology.

Devices in a piconet use a specific frequency hopping pattern, which is algorithmically determined by certain fields in the Bluetooth address and clock of the master. The basic hopping pattern is a pseudo-random ordering of the 79 frequencies in the ISM band. The hopping pattern may be adapted to exclude a portion of the frequencies that are used by interfering devices. The adaptive hopping technique improves Bluetooth co-existence with static (non-hopping) ISM systems when these are co-located.

The physical channel is sub-divided into time units known as slots. Data is transmitted between Bluetooth devices in packets, that are positioned in these slots. When circumstances permit, a number of consecutive slots may be allocated to a single packet. Frequency hopping takes place between the transmis-

Architecture

sion or reception of packets. Bluetooth technology provides the effect of full duplex transmission through the use of a Time-Division Duplex (TDD) scheme.

Above the physical channel there is a layering of links and channels and associated control protocols. The hierarchy of channels and links from the physical channel upwards is physical channel, physical link, logical transport, logical link and L2CAP channel. These are discussed in more detail in Section 3.3 on page 34 - Section 3.6 on page 50 but are introduced here to aid the understanding of the remainder of this section.

Within a physical channel, a physical link is formed between any two devices that transmit packets in either direction between them. In a piconet physical channel there are restrictions on which devices may form a physical link. There is a physical link between each slave and the master. Physical links are not formed directly between the slaves in a piconet.

The physical link is used as a transport for one or more logical links that support unicast synchronous, asynchronous and isochronous traffic, and broadcast traffic. Traffic on logical links is multiplexed onto the physical link by occupying slots assigned by a scheduling function in the resource manager.

A control protocol for the baseband and physical layers is carried over logical links in addition to user data. This is the link manager protocol (LMP). Devices that are active in a piconet have a default asynchronous connection-oriented logical transport that is used to transport the LMP protocol signalling. For historical reasons this is known as the ACL logical transport. The default ACL logical transport is the one that is created whenever a device joins a piconet. Additional logical transports may be created to transport synchronous data streams when this is required.

The Link Manager function uses LMP to control the operation of devices in the piconet and provide services to manage the lower architectural layers (radio layer and baseband layer). The LMP protocol is only carried on the default ACL logical transport and the default broadcast logical transport.

Above the baseband layer the L2CAP layer provides a channel-based abstraction to applications and services. It carries out segmentation and reassembly of application data and multiplexing and de-multiplexing of multiple channels over a shared logical link. L2CAP has a protocol control channel that is carried over the default ACL logical transport. Application data submitted to the L2CAP protocol may be carried on any logical link that supports the L2CAP protocol.



1.2 NOMENCLATURE

Where the following terms appear in the specification they have the meaning given in Table 1.1 on page 15.

Ad Hoc Network	A network typically created in a spontaneous manner. An ad hoc network requires no formal infrastructure and is limited in temporal and spatial extent.
Active Slave Broadcast (ASB)	The Active Slave Broadcast logical transport that is used to transport L2CAP user traffic to all active devices in the piconet. See Section 3.5.7 on page 46.
Beacon Train	A pattern of reserved slots within a basic or adapted piconet physical channel. Transmissions starting in these slots are used to resynchronize parked devices.
Bluetooth	Bluetooth is a wireless communication link, operating in the unlicensed ISM band at 2.4 GHz using a frequency hopping transceiver. It allows real-time AV and data communications between Bluetooth Hosts. The link protocol is based on time slots.
Bluetooth Baseband	The part of the Bluetooth system that specifies or implements the medium access and physical layer procedures to support the exchange of real-time voice, data information streams, and ad hoc networking between Bluetooth Devices.
Bluetooth Clock	A 28 bit clock internal to a Bluetooth controller sub-system that ticks every 312.5µs. The value of this clock defines the slot numbering and timing in the various physical channels.
Bluetooth Controller	A sub-system containing the Bluetooth RF, baseband, resource controller, link manager, device manager and a Bluetooth HCI.
Bluetooth Device	A Bluetooth Device is a device that is capable of short-range wireless communications using the Bluetooth system.
Bluetooth Device Address	A 48 bit address used to identify each Bluetooth device.
BD_ADDR	The Bluetooth Device Address, BD_ADDR, is used to identify a Bluetooth device.
Bluetooth HCI	The Bluetooth Host Controller Interface (HCI) provides a command interface to the baseband controller and link manager and access to hardware status and control registers. This interface provides a uniform method of accessing the Bluetooth baseband capabilities.

Table 1.1: Nomenclature.

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Bluetooth Host	A Bluetooth Host is a computing device, peripheral, cellular telephone, access point to PSTN network or LAN, etc. A Bluetooth Host attached to a Bluetooth Controller may communicate with other Bluetooth Hosts attached to their Bluetooth Controllers as well.
Channel	Either a physical channel or an L2CAP channel, depending on the context.
Connect (to service)	The establishment of a connection to a service. If not already done, this also includes establishment of a physical link, logical transport, logical link and L2CAP channel.
Connectable device	A Bluetooth device in range that periodically listens on its page scan physical channel and will respond to a page on that channel.
Connected devices	Two Bluetooth devices in the same piconet and with a physical link between them.
Connecting	A phase in the communication between devices when a connection between them is being established. (Connecting phase follows after the link establishment phase is completed.)
Connection	A connection between two peer applications or higher layer protocols mapped onto an L2CAP channel.
Connection establishment	A procedure for creating a connection mapped onto a channel.
coverage area	The area where two Bluetooth devices can exchange messages with acceptable quality and performance.
Creation of a secure connection	A procedure of establishing a connection, including authentication and encryption.
Creation of a trusted relationship	A procedure where the remote device is marked as a trusted device. This includes storing a common link key for future authentication and pairing (if the link key is not available).
Device discovery	A procedure for retrieving the Bluetooth device address, clock, class-of-device field and used page scan mode from discoverable devices.
Discoverable device	A Bluetooth device in range that periodically listens on an inquiry scan physical channel and will respond to an inquiry on that channel. Discoverable device are normally also connectable.
Inquiring device	A Bluetooth device that is carrying out the inquiry procedure.
Inquiry	A procedure where a Bluetooth device transmits inquiry messages and listens for responses in order to discover the other Bluetooth devices that are within the coverage area.

Table 1.1: Nomenclature.

Architecture



Inquiry scan	A procedure where a Bluetooth device listens for inquiry messages received on its inquiry scan physical channel
Interoperability	The ability of two or more systems or components to exchange information and to use the information that has been exchanged.
Isochronous data	Information in a stream where each information entity in the stream is bound by a time relationship to previous and successive entities.
Known device	A Bluetooth device for which at least the BD_ADDR is stored.
L2CAP Channel	A logical connection on L2CAP level between two devices serving a single application or higher layer protocol.
L2CAP Channel establishment	A procedure for establishing a logical connection on L2CAP level.
Link establishment	A procedure for establishing the default ACL link and hierarchy of links and channels between devices.
Link	Shorthand for a logical link.
Link key	A secret key that is known by two devices and is used in order to authenticate each device to the other
LMP authentication	An LMP level procedure for verifying the identity of a remote device
LMP pairing	A procedure that authenticates two devices and creates a common link key that can be used as a basis for a trusted relationship or a (single) secure connection.
Logical Channel	Identical to an L2CAP channel, but deprecated due to an alternative meaning in Bluetooth 1.1
Logical link	The lowest architectural level used to offer independent data transport services to clients of the Bluetooth system.
Logical transport	Used in Bluetooth to represent commonality between different logical links due to shared acknowledgement protocol and link identifiers.
Name discovery	A procedure for retrieving the user-friendly name (the Bluetooth device name) of a connectable device.
Packet	Format of aggregated bits that are transmitted on a physical channel
Page	The initial phase of the connection procedure where a device transmits a train of page messages until a response is received from the target device or a time-out occurs.
Page scan	A procedure where a device listens for page messages received on its page scan physical channel.

Table 1.1. Nomenclature.

Architecture



Paging device	A Bluetooth device that is carrying out the page procedure.
Paired device	A Bluetooth device with which a link key has been exchanged (either before connection establishment was requested or during connecting phase).
Parked device	A device operating in a basic mode piconet that is synchronized to the master but has given up its default ACL logical transport.
Physical Channel	Characterized by synchronized occupancy of a sequence of RF carriers by one or more devices. A number of physical channel types exist with characteristics defined for their different purposes.
Physical Link	A Baseband-level connection between two devices established using paging.
Piconet	A collection of devices occupying a shared physical channel where one of the devices is the Piconet Master and the remaining devices are connected to it.
Piconet Physical Channel	A Channel that is divided into time slots in which each slot is related to an RF hop frequency. Consecutive hops normally correspond to different RF hop frequencies and occur at a standard hop rate of 1600 hops/s. These consecutive hops follow a pseudo-random hopping sequence, hopping through a 79 RF channel set.
Piconet Master	The device in a piconet whose Bluetooth Clock and Bluetooth Device Address are used to define the piconet physical channel characteristics.
Piconet Slave	Any device in a piconet that is not the Piconet Master, but is connected to the Piconet Master.
PIN	A user-friendly number that can be used to authenticate connections to a device before pairing has taken place.
PMP	A Participant in Multiple Piconets. A device that is concurrently a member of more than one piconet, which it achieves using time division multiplexing (TDM) to interleave its activity on each piconet physical channel.
The Parked Slave Broadcast (PSB)	The Parked Slave Broadcast logical transport that is used for communications between the master and parked devices. Section 3.5.8 on page 47.
Scatternet	Two or more piconets that include one or more devices acting as PMPs.
Service Layer Protocol	A protocol that uses an L2CAP channel for transporting PDUs.
Service discovery	Procedures for querying and browsing for services offered by or through another Bluetooth device.

Table 1.1. Nomenclature.

Architecture



Silent device	A Bluetooth device appears as silent to a remote device if it does not respond to inquiries made by the remote device.
Unknown device	A Bluetooth device for which no information (Bluetooth Device Address, link key or other) is stored.

Table 1.1: Nomenclature